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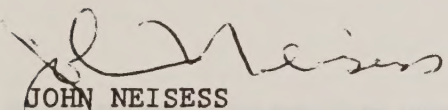
Date: February 5, 1993

Subject: Alternatives to Benlate for Control of Septoria Leaf Spot on
Alder Seedlings and Reduction of Gray Mold on 2-0 Douglas-fir
(Rpt. No. R93-2)

To: Forest Supervisor, Six Rivers National Forest

Enclosed is a copy of a biological evaluation entitled "Alternatives to Benlate for Control of Septoria Leaf Spot on Alder Seedlings and Reduction of Gray Mold on 2-0 Douglas-fir". The withdrawal of the ornamental registrations for Benlate and Botran left the Humboldt Nursery without legal, tested, effective fungicides for use to control Septoria leaf spot on alder and gray mold on Douglas-fir. This paper summarizes the methods and results for two 1992 trials that tested alternative registered fungicides to replace Benlate or Botran.

If you have any questions or comments concerning this report, contact FPM Plant Pathologist Susan Frankel at 415-705-2651.


JOHN NEISESS
FPM Program Leader
State and Private Forestry

Enclosure



**Alternatives to Benlate® for Control of Septoria Leaf Spot on Alder Seedlings
and Reduction of Gray Mold on 2-0 Douglas-fir**

Susan Frankel, Plant Pathologist and James Nelson, Supervisory Forestry Technician

The withdrawal of the ornamental registrations for Benlate® and Botran left the USDA Forest Service Humboldt Nursery without tested, legal, and effective pesticides to use for two of its persistent pest problems, Septoria leaf spot on alder and gray mold on Douglas-fir. This paper will summarize the methods and results for two trials done to test alternative fungicides for Benlate® and Botran: Part I summarizes the alder trial, Part II summarizes the trial in Douglas-fir.

PART I Alternatives to Benlate® for Control of Septoria Leaf Spot on White and Red Alder

ABSTRACT

White and red alder seedlings were treated with Fungo® Flo, Cleary's 3336-F™ (with and without a surfactant), Benlate® or water to compare their ability to control Septoria leaf spot. All the fungicides were effective in suppressing this pathogen, when compared to water-treated controls, but a 2 week application interval was superior to monthly treatment. In white alder, means for height and caliper of fungicide-treated seedlings were significantly larger than means for height and caliper of controls. In both red and white alder, the number of Septoria stem infections was significantly ($p=.05$) lower for fungicide-treated plots when compared to water-treated control plots.

INTRODUCTION

Since alder was added to Humboldt Nursery's crop production regime, Septoria leaf spot, caused by the fungus *Septoria alnifolia*, has been a persistent pest. In 1988, nearly 150,000 white alder seedlings, over 90% of the crop, were lost due to fungal infection. The fungus causes black spots on leaves and stems; if infection occurs when the seedlings are small, the lesion girdles the stem, killing the seedling. Red alder is less susceptible to *Septoria*; necrotic spots develop on its lower leaves but fewer infections result in mortality.

In 1989, Benlate® (benomyl) was shown to be effective for the control of Septoria leaf spot on white alder (Frankel 1990). In that test, benomyl spray applications were made monthly, from May to November at a rate of 8 oz/100 gals. The monthly applications reduced losses due to disease to less than 5% of the crop.

In 1991, in a subsequent trial, alder were thinned to various seedbed densities to determine if increased spacing would reduce damage due to Septoria leaf spot. The seedbed density trial, with monthly Benlate® spray applications for comparison, once again demonstrated the efficacy of spraying with Benlate® while seedbed density did not have an effect on disease severity, seedling height or caliper (Frankel and Nelson 1992).

On September 11, 1991, DuPont withdrew the Benlate® ornamental label, thereby prohibiting the use of Benlate® for Septoria leaf spot control (Chase et. al 1991). Alternative fungicides with a similar chemical structure to Benlate® (thiophanates) remain registered with the EPA for ornamental use including: Cleary 3336-F™ (Topsin M) and Fungo® Flo. The active ingredients of these products are slightly different from Benlate®. The active ingredient in Benlate® is benomyl, Methyl 1 - (butylcarbomoyl) - 2- benzimidazolecarbamate. The active ingredient in both Fungo® flo and 3336-F™ is thiophanate-methyl. Both of these active ingredients belong to the same chemical group, benzimidazoles. Once these benzimidazoles mix with water and are absorbed by the plant, the active metabolite (MBC) is the same for both materials. This trial tested 3336-F™ (with and without a surfactant) and Fungo® Flo to determine if they are effective at controlling Septoria leaf spot on white and red alder at the Humboldt Nursery.

Background Information on Fungo® flo and 3336-F™

Fungo® Flo (EPA Registration No. 4581-352-58185) distributed by Grace Sierra and 3336-F™ (EPA Registration No. 4581-352-1001) marketed by W.A. Cleary Company are very similar products. They are both turf and ornamental systemic fungicides, composed of 46.2% thiophanate - methyl and 53.8% inert ingredients. They have "Caution" warning labels and can cause moderate eye irritation. These pesticides are toxic to fish, so application is not recommended in areas where surface water is present or run-off is likely to occur. They can not be mixed with copper containing fungicides or alkaline material such as Bordeaux mixture or lime sulfur (W.A. Cleary 1990, Grace Sierra No date).

METHODS

Plots were set up in white and red alder seedbeds at the USDA Forest Service Humboldt Nursery in northern California. A randomized complete block design was used with 5 treatments replicated 4 times in white alder and 5 treatments replicated 5 times in red alder. (The amount of white alder grown at Humboldt did not allow for more than 4 replicates). Each replicate measured 6 feet long and was one nursery bed wide (4 feet). The following treatments were compared:

1. Cleary 3336-F™, 10 oz/100 gals, (1 Tsp/2 gals) applied every 2 weeks from date first leaf is fully grown through lift (June to October).
2. Cleary 3336-F™, 10 oz/100 gals, (1 Tsp/2 gals) with Clearspray surfactant (1 part Clearspray to 10 parts water) sprayed monthly from date first leaf is fully grown through lift (June to October).
3. Benlate® 8 oz/100 gals, (1/2 Tbl/1 gal) applied monthly from date first leaf is fully grown through lift (June to October).
4. Fungo® Flo, 10oz/100 gals,(1 Tsp/2 gals) applied every 2 weeks from date first leaf is fully grown through lift (June to October).
5. Control - water only, applied every 2 weeks from date first leaf is fully grown through lift.

Fungicides were applied following label directions, using a backpack sprayer with foliage sprayed to run-off. Seedlings were grown using operational nursery methods.

Near the end of the growing season, on October 15, 1992, 20 randomly selected seedlings from each plot were harvested for disease evaluation and growth measurements. Seedlings were clipped at the soil line; height and caliper at the base were measured. Disease severity was visually estimated and stem infections counted. Analysis of variance was used for comparison of means.

RESULTS AND DISCUSSION

Seedlings in all treatments developed a rust that caused their leaves to fall prematurely. The rust, most likely *Melampsoridium alni*, was also widespread in mature alder trees surrounding the nursery. This rust is not considered damaging, causing premature defoliation but no other significant harm to seedlings or mature alder trees. It did interfere with quantitative evaluation of the number of *Septoria* leaf spots in this trial. The number of stem infections is not affected by the rust infection and is a good measure of *Septoria* control. Stem infections are particularly damaging; if they develop when the seedling is small, they can girdle the seedling and cause death. In larger seedlings (greater than 4mm caliper at the base), they can cause top kill. Also, stem infections may be transplanted to the outplanting site, unlike leaf infections which are shed and left behind in the nursery.

In white alder, Benlate®, Fungo® Flo and Cleary 3336-F™ all suppressed *Septoria* leaf spot, producing seedlings that were significantly ($p=.05$) taller, stouter and healthier than water-treated controls (See Table 1). Disease severity, based on number of stem infections was lowest for 4 week treatment interval application of Benlate® (0 stem infections), followed by Fungo®flo (2.5% stem infections), and 3336-F™ (10% with stem infections). The monthly application of 3336-F™ with Clearspray surfactant allowed 23% of the seedlings to develop stem infections. Seedlings with stem infections are considered poor quality and are culled, so using a monthly application of 3336-F™ with surfactant would not reduce losses due to *Septoria* to an acceptable level.

Means for Growth Measurements & Stem Infections – White Alder Trial

	Treatment	Height (cm)	Caliper (mm)	Stem infections (%)
1.	3336-F™, 2 week application	43.0	5.1	10.0
2.	3336-F™ + Clearspray, 4 week application	39.8	5.2	23.0
3.	Benlate®, 4 week application	41.2	5.1	0.0
4.	Fungo® Flo, 2 week application	37.8	5.1	2.5
5.	Water only, control	24.5	4.2	45.0

Table 1. Height, caliper and number of stem infections, average of 4 replicate plots, from white alder seedlings treated with various fungicides or water as a control. The sample from each plot consisted of 20 randomly selected seedlings. Means for height and caliper of control plot seedlings were significantly smaller ($p=.05$) than height and caliper means for all fungicide treatments. Number of stem infections was significantly higher in control plots when compared to fungicide-treated plots ($p=.05$).

In red alder, *Septoria* leaf spot was adequately controlled in all fungicide-treated plots. There were stem infections on 5% of the control seedlings and none on any of the fungicide-treated seedlings. There also were no significant differences between the seedling heights from the fungicide treatments and the controls. Number of stem infections in control plots were significantly ($p=.05$) greater than number of stem infection in fungicide-treated plots (See Table 2). The mean caliper of the seedlings treated monthly with Cleary

3336-F™ and Clearspray surfactant was significantly smaller (4.68 mm) than mean caliper for the 2 week application of 3336-F™.

Means for Growth Measurements & Stem Infections – Red Alder Trial

	Treatment	Height (cm)	Caliper (mm)	Stem infections (%)
1.	3336-F™, 2 week application	62.9	5.8	0.0
2.	3336-F™ + Clearspray, 4 week application	59.0	4.7	0.0
3.	Benlate®, 4 week application	66.8	5.5	0.0
4.	Fungo® Flo, 2 week application	66.4	5.4	0.0
5.	Water only, control	60.6	5.0	5.0

Table 2. Height, caliper and number of stem infections, average of 4 replicate plots, from red alder seedlings treated with various fungicides or water as a control. The sample from each plot consisted of 20 randomly selected seedlings. Number of stem infections for control plots was significantly ($p=.05$) greater than all fungicide-treated plots. Mean caliper for the 2 week and 4 week applications of 3336-F™ were also significantly different ($p=.05$).

Due to the low percentage of control seedlings with stem infections and apparent lack of growth reduction due to Septoria leaf spot, the need for any type of fungicide treatment in red alder is not clear. It probably would be beneficial to treat red alder beds adjacent to white alder beds to prevent infections that start on red alder from spreading into the highly susceptible white alder seedlings. Another alternative is to grow the red and white alder crops at the opposite ends of the nursery grounds, which should also restrict disease movement.

In both the red and white alder trials, the results for the two week applications of Fungo® Flo and 3336-F™ are similar. Since both materials have the same active ingredient, thiophanate-methyl, this is expected. Currently only Fungo® Flo is registered for use in California Nurseries.

CONCLUSIONS

Fungo®Flo or Cleary 3336-F™ (after it becomes registered for use in California) applied at two week intervals is recommended to protect white alder seedlings from Septoria leaf spot. Since red alder is much less susceptible to Septoria leaf spot, preventive fungicide treatment is not required.

PART II Alternatives to Benlate® and Botran for Reduction of Gray Mold on 2-0 Douglas-fir

At the USDA Forest Service Humboldt Nursery, Benlate® and Botran have been used in rotation for control of Douglas-fir with gray mold, caused by the fungus *Botrytis cinerea*. Fungicide resistance develops rapidly with *Botrytis*, so more than one fungicide is needed to slow or prevent this reduction in fungicide effective-

ness. In 1991, ornamental registrations for Benlate® and Botran were withdrawn so alternative fungicides were needed to limit gray mold on Douglas-fir.

Gray mold, is aptly named; if conditions are favorable the fungus appears as a gray fluffy mass on dead lower branches or needles. Upon close examination, thin black stems with gray spores in bulky clusters can be seen. Gray mold produces cankers and dark sclerotia as the infection develops. It can infect many plant species and is particularly troublesome where air is moist and stagnant. These conditions often occur in the second year of 2-0 Douglas-fir production when the lower branches of seedlings intertwine to form a closed canopy. Gray mold can also appear after a freeze or mechanical injury causes some plant parts to die; it rapidly colonizes senescent tissue and then spreads to adjacent live tissues (Russell 1990, Srago and McCain 1989).

In this trial, Fungo® flo, and Chipco® 26019 (iprodione) were compared to Benlate® and Botran for efficacy in reducing colonization of gray mold. Fungo®flo is a thiophanate-methyl with a similar active ingredient to Benlate®, and is relatively nontoxic to humans and the nursery environment (for further information see Part 1 of this report). Chipco® 26019 (Chemical and Pharmaceutical Press 1991) has been used for gray mold control in Pacific Northwest forest nurseries and is registered for use in California.

METHODS

A 2-0 Douglas-fir bed with a crowded canopy was selected for plot installation. A randomized complete block design was used with 5 treatments replicated 5 times. Each replicate measured 6 feet long and was one nursery bed wide (4 feet). The following treatments were compared:

1. Fungo®Flo (thiophanate-methyl) 10 oz/100 gals, (1 tsp/2 gals) applied the week of August 14 and again the week of Sept 14.
2. Chipco® 26019 (iprodione), 1 lb/ac, applied the week of of August 14 and again the week of Sept 14.
3. Benlate® (benomyl) 8 oz/100 gals (1/2 Tsp/2 gals) applied the week of August 14 and again the week of Sept. 14.
4. Botran (DCNA) 1 lb/ac (2 Tbl/2 gals) applied the week of August 14 and again the week of Sept. 14.
5. Water only, applied the week of August 14 and again the week of Sept. 14.

Chemicals were applied according to label directions, using a backpack sprayer with foliage sprayed to run-off. The backpack sprayer's wand was placed in the bottom half of the seedling canopy, to ensure that the fungicides reached the lower crown where infection typically starts. Seedlings were grown using operational nursery methods.

Near the end of the growing season, on October 15, 1992, 20 seedlings from each plot were randomly harvested by clipping at the ground line. The length of stem covered with gray mold was measured to compare disease severity. Analysis of variance was used to test for significance of differences between means.

RESULTS

Both Fungo®Flo and Chipco 26019 suppressed gray mold infection to tolerable levels (See Table 3). Neither fungicide provided as good protection as Benlate® or Botran, but differences in average infection length, and average number of seedlings without any visible mold, were not statistically significant ($p=.05$). All fungicide

treated seedling plot means for length of colonization or percentage of seedlings without gray mold were not significantly different from the water-treated plots ($p=.05$) due to high variation between replicate plots.

Effect of Fungicide Treatment on Gray Mold Severity on Douglas-fir

	Treatment	Infection Length (Cm)	Range (cm)	% of Seedlings Without Mold
1.	Fungo® Flo,	1.9	0 - 12	47%
2.	Chipco®26019	1.6	0 - 11	43%
3.	Benlate®	1.3	0 - 5	55%
4.	Botran	1.1	0 - 7	51%
5.	Water only	5.2	0 - 17	21%

Table 3. Differences between means for length (in cm) of stem colonization by gray mold on 2-0 Douglas-fir and percentage of seedlings without visible mold. Values are an average of 5 replicate plots, treated with various fungicides or water as a control. The sample from each plot consisted of 20 randomly selected seedlings. Differences between means for all treatments were not statistically significant at $p=.05$ for both variables analyzed.

Many seedlings in all treatments were colonized by *Thelephora terrestris*, an ectomycorrhizal fungus that is usually considered beneficial to seedling growth (Landis et. al 1989). The presence of fruiting bodies of this mycorrhizal fungus indicates that the fungicides do not kill all fungi present at the time of treatment. This somewhat selective activity is desirable because it allows beneficial mycorrhizal and decomposer fungi to remain active in the nursery beds while reducing gray mold colonization.

After seedlings are lifted and packed, gray mold can still develop during storage, particularly if seedlings have been damaged by fertilizer burn, cold or mechanical injury (Sutherland et al. 1982) or packed with excess soil. The fungus thrives under cool conditions, such as those in a seedling cooler. Treating with fungicide during the growing season or just prior to lifting can suppress *Botrytis* but growing vigorous, undamaged stock and lifting, packing and storing it properly will prevent *Botrytis* without the need for fungicide treatment. Fungicide treatment may also be avoided by thinning the 2-0 Douglas-fir beds or sowing them at lower density. The increased aeration provides a less suitable habitat for the fungus (Russell 1990, Chase et al. 1991).

CONCLUSIONS

Both Fungo®flo and Chipco 26019 are acceptable replacements for Benlate® and Botran when a fungicide is needed to suppress gray mold. These fungicides should be used in rotation to prevent the development of fungal resistance. Wide spacing, proper fertilization and prevention of mechanical injury should prevent the development of gray mold and eliminate the need for fungicide application of Douglas-fir.

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ACKNOWLEDGMENTS

The technical assistance of Ruth Tramble and Lavelle Frisbee of the Humboldt Nursery is greatly appreciated.

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